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CORRECTION

Correction: Mars orientation and rotation angles

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In original publication, the Abstract section has been published incorrectly. The correct version is updated in this correction.

Abstract

The rotation and orientation of Mars is commonly described using two different sets of angles, namely (1) the Euler angles with respect to the Mars orbit plane and (2) the right ascension, declination, and prime meridian location angles with respect to the Earth equator at J2000 (as adopted by the IAU). We propose a formulation for both these sets of angles, which consists of the sum of a second degree polynomial and of periodic and Poisson series. Such a formulation is shown here to enable accurate (and physically sound) transformation from one set of angles to the other. The transformation formulas are provided and discussed in this paper. In particular, we point that the quadratic and Poisson terms are key ingredients to reach a transformation precision of 0.1 mas, even 30 years away from the reference epoch of the rotation model (e.g., J2000). Such a precision is required to accurately determine the smaller and smaller geophysical signals observed in the high-accuracy data acquired from the surface of Mars. In addition, we present good practices to build an accurate Martian rotation model over a long time span (±30 years around J2000) or over a shorter one (e.g., lifetime of a space mission). We recommend to consider the J2000 mean orbit of Mars as the reference plane for Euler angles. An accurate rotation model should make use of up-to-date models for the rigid (this study) and liquid (Le Maistre et al., Nature 619, 733–737 (2023)) nutations, relativistic corrections in rotation (Baland et al., Astron. Astrophys. 670, A29 (2023)), and polar motion induced by the external torque (this study). Our transformation model and recommendations can be used to define the future IAU solution for the rotation and orientation of Mars using right ascension, declination, and prime meridian location. In particular, thanks to its quadratic

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terms, our transformation model does not introduce arbitrary and non-physical terms of very long period and large amplitudes, thus providing unbiased values of the rates and epoch values of the angles.

The original article has been corrected.

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